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SUPPLEMENT TO

TWENTY - FIFTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER COMPANY

ON

105 MM. BATTALION ANTI-TANK PROJECT

UNDER

Contract No. DA-33-019-ORD-33

ORDNANCE DEPARTMENT PROJECTS

TS4-4020—WEAPONS AND ACCESSORIES

TM1-1540—AMMUNITION

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COPY No. 3

THE FIRESTONE TIRE & RUBBER COMPANY
Defense Research Division
Akron, Ohio

AUGUST 1952

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SUPPLEMENT TO

TWENTY-FIFTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

105 MM BATTALION ANTI-TANK PROJECT

Contract No.
DA-33-019-ORD-33 (Negotiated)
RAD ORDTS 1-12383

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

AUGUST, 1952

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ABSTRACT

The use of double body projectiles as a means of overcoming the serious effect of spin upon the penetration of shaped charges is discussed and the previous work briefly summarized.

The tests, presented in this report, concerning double body projectiles are (1) static load-torque tests of flat step bearings, using Molykote and Foscoat surface treatments; (2) dynamic firing tests of spherical pivot bearings with excess Molykote; and (3) dynamic firing tests with two types of ball bearing assemblies. The data are presented and discussed.

A future program for spin compensation studies is given.

Double Body Projectiles

The use of a double body projectile, consisting of a rotating stabilizing section and a slowly rotating charge-carrying section, for overcoming the serious effect of spin upon the penetration of shaped charges, has been described in the Supplements to the Thirteenth and Sixteenth Progress Reports. The success of such a projectile depends upon solving the two following problems: (1) Development of bearings and lubricants of sufficiently low friction and high load-carrying capacity to assure that the "non-rotating" charge section will not build up too high a spin rate. (2) Development of a stabilizing section capable of maintaining the accuracy of the total projectile without exceeding the desired light weight of the projectile. Although some consideration has been given the second problem the major emphasis has been placed upon the first. The earlier reports have presented the results of static and dynamic tests using various bearings and lubricants. These tests have been continued.

The tests presented in this report are the following:

1. Static load-torque behavior of flat step bearings (DRA 215-218) with excess Molykote and with four different Foscoat surface treatments.

2. Dynamic firing tests of spherical pivot bearings (DRA 216-219) with excess Molykote.

3. Dynamic firing tests with two types of ball bearing assemblies.

The projectiles were all fired from a T19 rifle, rifled 1/20, modified to have a 500 cubic inch chamber. The charge was sufficient to impart a muzzle velocity of 1700 ft/sec (nominal) at 10,000 lbs/sq in (c pper). At 1700 ft/sec muzzle velocity the spin rate of the rotated section is approximately 240 rev/sec. The spin rate of the non-rotated section was determined by using three wire screens at known spacings.

Effect of Foscoat Treatments

A series of DRA 215-218 flat step bearings, assembled as shown in Figure 1, were sent to Heintz Manufacturing Co. for Foscoat surface treatment. The following Foscoat treatments were tested: (1) Thin, (2) Heavy, (3) Thin with added Molykote, (4) Heavy with added Molykote. Though the advantages claimed for Foscoat lubricants become evident only under extreme conditions, the static load-torque behavior of these bearings was determined. The method used is as indicated schematically in Figure 2. The test data are shown in Figure 3. A curve for an untreated DRC 215-218 bearing system with a large excess of Molykote is shown for comparison. The untreated bearing, lubricated with a large excess of Molykote, seemed so superior to the Foscoat lubricated bearings that the Foscoat bearing, thin with Molykote, was retested with a large excess of Molykote. The excess Molykote caused a marked reduction in the torque of the bearing system.

The data for the firing tests with these bearings are reported in Table I. The measured spin rates were all between 38 and 52 rev/sec. The two heavy Foscoat treatments were inferior to the thin Foscoat treatments. The addition of a small amount of Molykote in the Foscoat treatment did not result in any noticeable improvement in performance. The thin Foscoat treatment was equivalent to the untreated bearing lubricated with a large excess of Molykote. These tests confirm the remarkable lubricating properties claimed for Foscoat treated surfaces.

Spherical Pivot Bearings

Three projectiles with spherical pivot bearings, assembled as shown in Figure 4, were fired for spin rate measurements. The bearings were hardened to R_c 48, 50, and 55, respectively. All were lubricated with an excess of Molykote. The spin data are shown in Table I. The spin rate decreased from 35 rev/sec to 31 rev/sec with increasing hardness of the bearing. All were superior to the flat pivot bearings.

Ball Bearing Test

Four projectiles with two different types of ball bearings were tested. One pair contained the Messinger ball bearings (DRC 389), the second pair contained Nice #715 bearings. The latter is a very inexpensive bearing with a pressed steel race. The two types of projectiles are shown in Figure 5. The spin data are shown in Table I. The precision made Messinger bearings had measured spin rates of 28 and 31 rev/sec, the large tolerance Nice #715 bearings failed and spin rates of 106 and 122 rev/sec were observed. The bearings were examined after recovery and are shown in Figure 6. The recovered Fafnir #4321 bearing whose performance was reported in the Supplement to the Sixteenth Report, is shown also. In each case some Brinelling of the race is observed but after cleaning both the Messinger bearing, DRC 389, and the Fafnir #4321 bearings operated quite satisfactorily. The two Nice #715 bearings failed badly and confirm that this application will require a well made and strong bearing. Because the DRC 389 bearings appeared quite satisfactory this bearing will be used in tests with actual projectiles, in an effort to solve the problem of accuracy and flight stability.

Future Program

1. Serrated Liners

a. DRD 267, 60 flat flutes pressed on exterior surface only, .0107 in. nominal depth, .100-inch wall, 42° copper cone. These liners are ready for loading.

b. DRD 267, same as a except aluminum cones are to be made.

c. DRD 318, 36 flutes pressed into interior surface only, .010 in. nominal flute depth, .100-inch wall thickness (42° copper cone).

d. DRD 319, 45 flutes but otherwise similar to c.

e. DRD 320 (a), 60 flutes but otherwise similar to c.

f. DRD 320 (b), similar to e except flute depth is .020 in.

g. DRD 320 (c), similar to e except flute depth is .040 in.

h. DRD 321, 100 flutes but otherwise similar to c.

i. DRD 78 modified by change of indexing. 16 curved flutes, internal and external, with an indexing angle of 5°. Nominal flute depth is .030 inch, wall thickness is .100 inch.

2. Double Body Projectiles

a. Firing tests with test slugs to determine muzzle spin rate of an assembly using races from Fafnir #4321 bearings but with a full complement of balls and without a cage.

b. Test Double body projectiles with DRC 389 bearings for spin rate and accuracy.

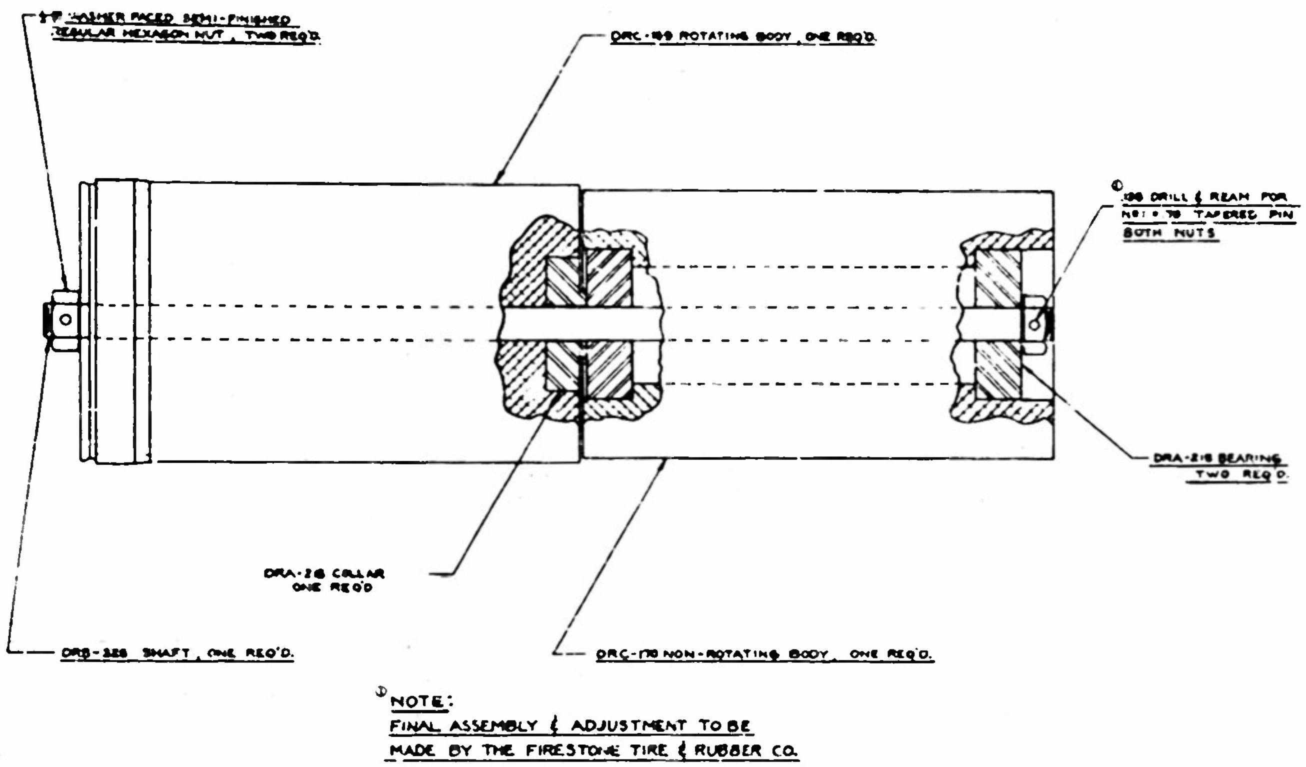


Fig. 1. Flat Step Bearing Assembly.

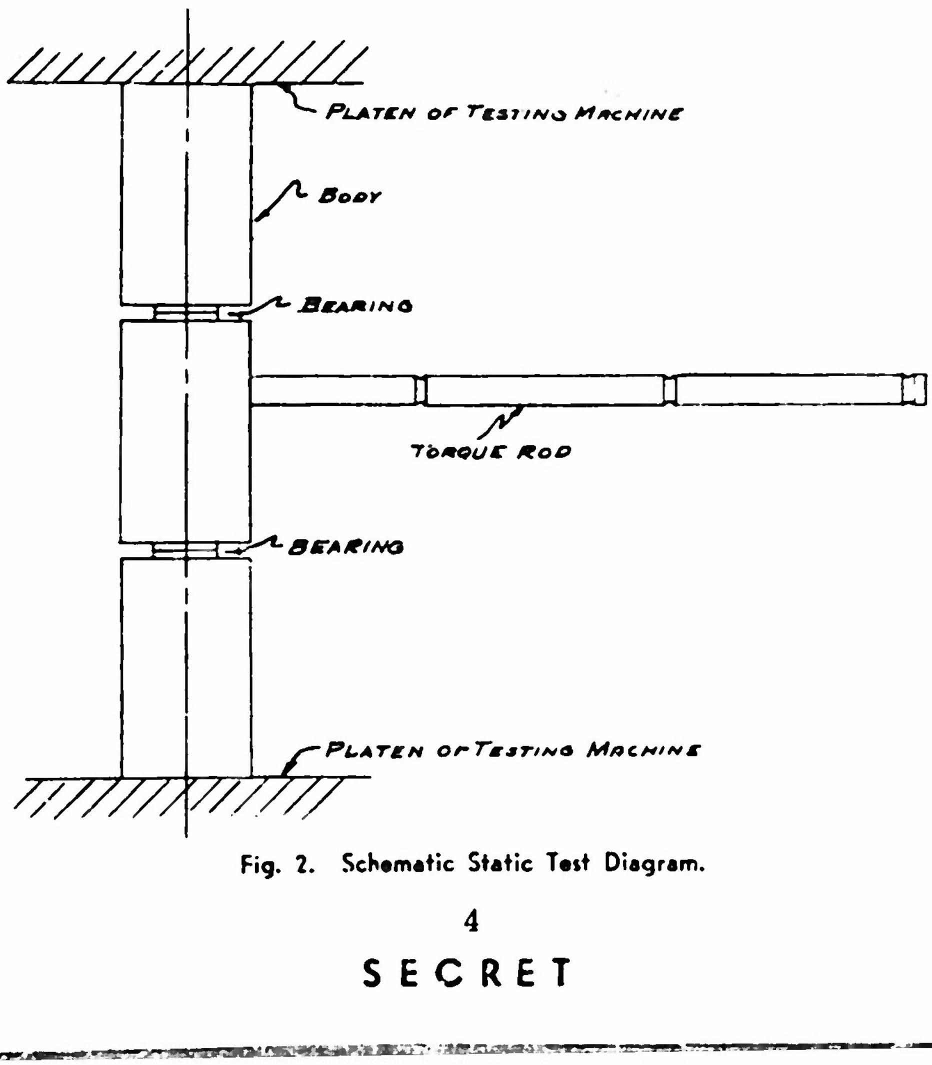


Fig. 2. Schematic Static Test Diagram.

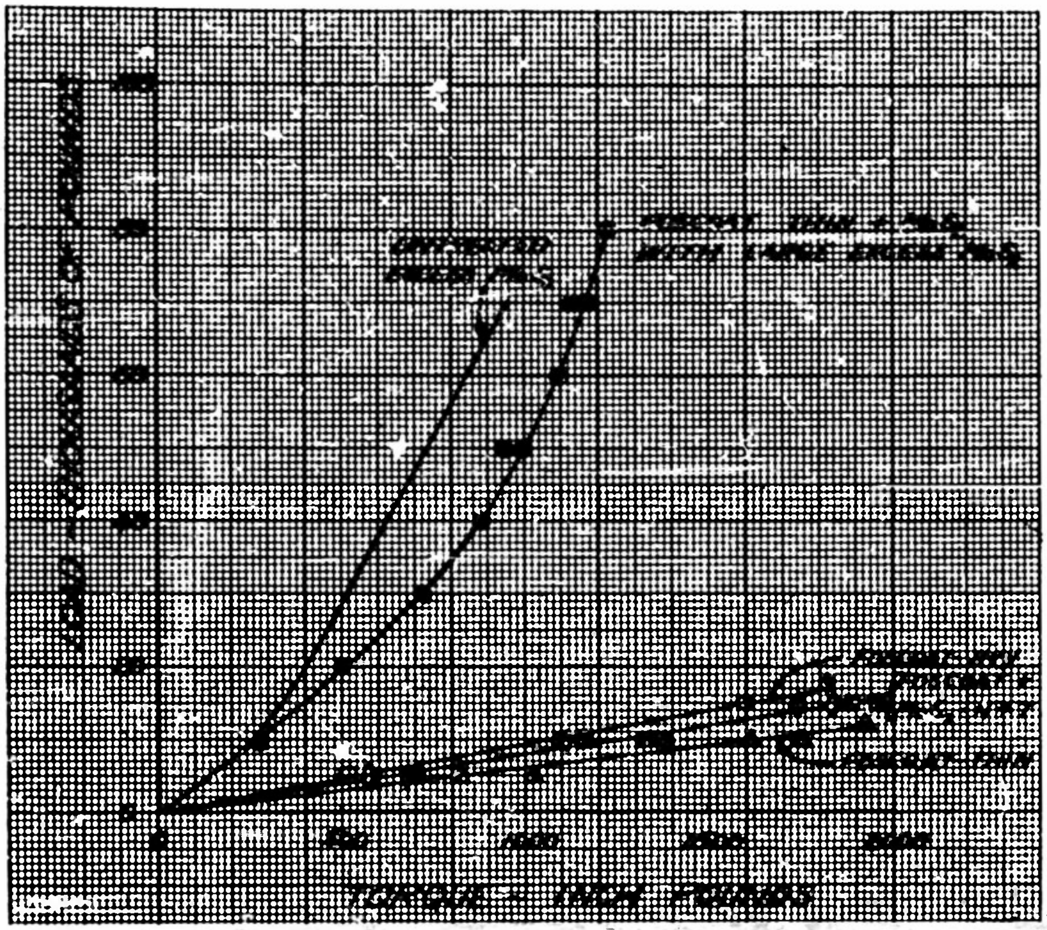
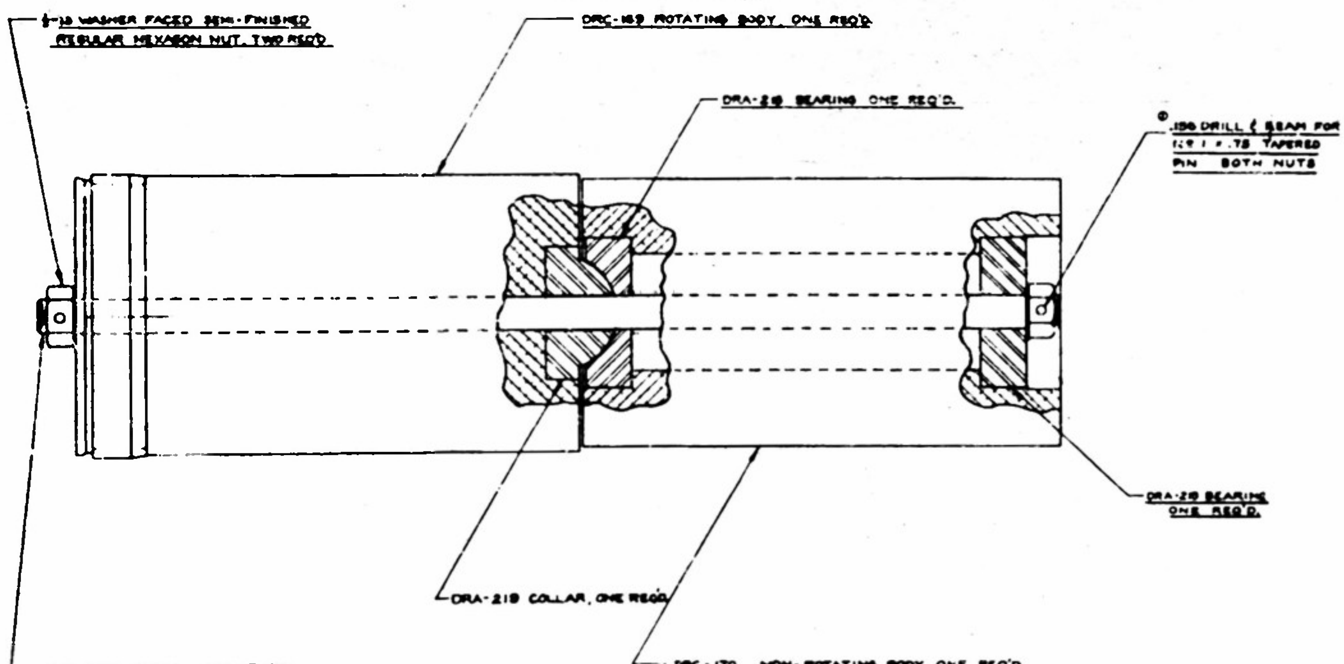


Fig. 3. Load-Torque Behavior.
DRA 218-215 Bearings.



NOTE:
FINAL ASSEMBLY & ADJUSTMENT TO BE MADE BY THE FIRESTONE TIRE & RUBBER CO.

Fig. 4. Spherical Bearing Assembly.

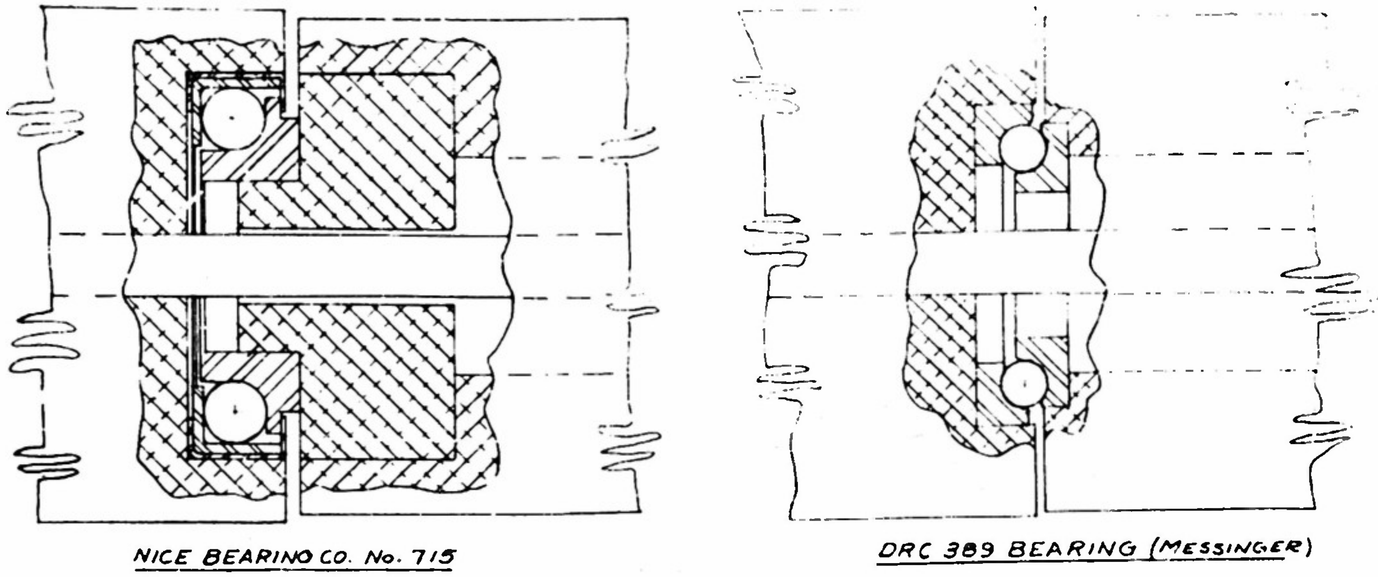


Fig. 5. Two Ball Bearing Installations.

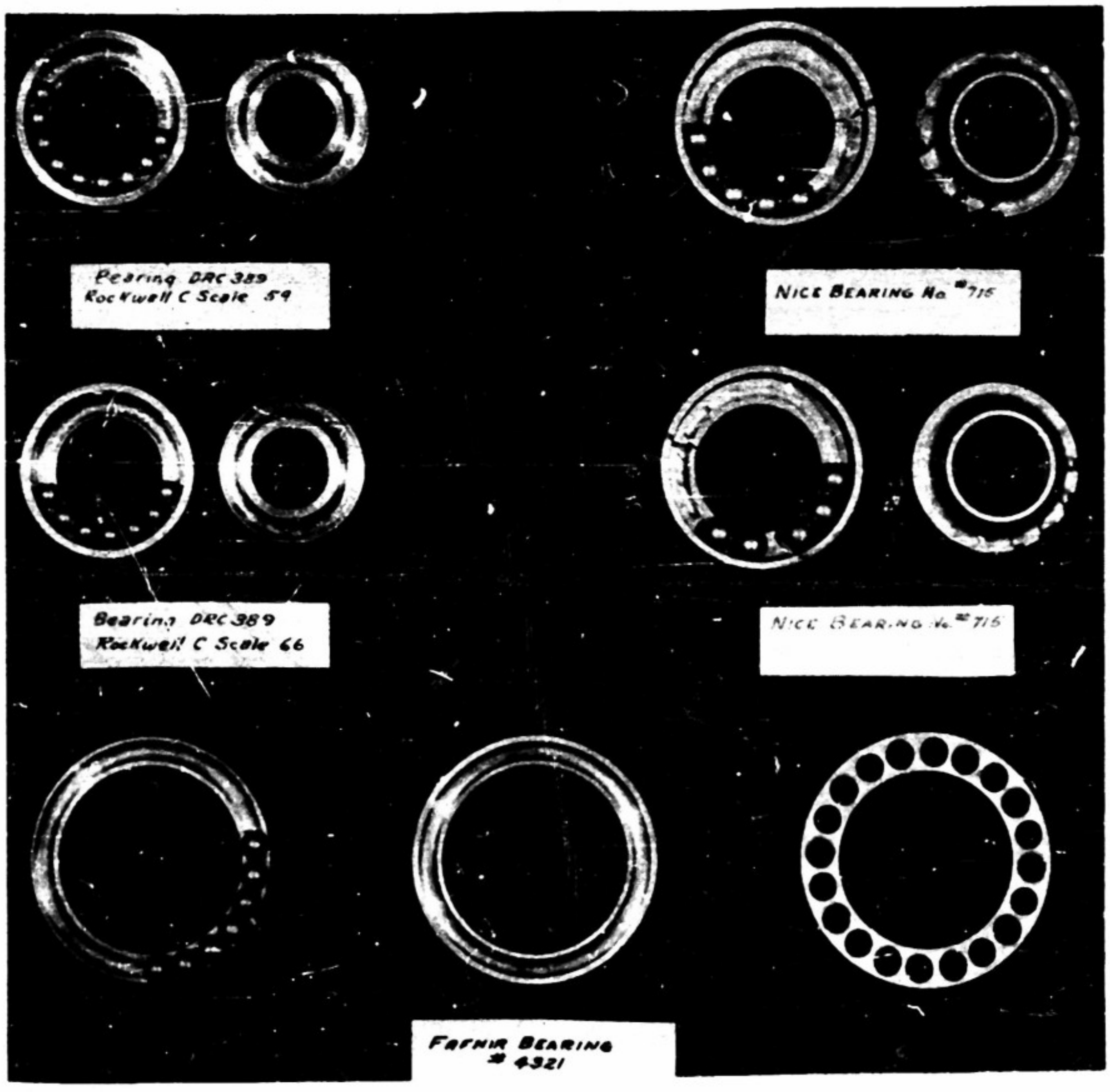


Fig. 6. Recovered Bearings.

Table I
Dynamic Test Data for Bearings and Lubricants

Round No.	Bearing Type	Hardness	Lubricant	Projectile Weight-lb.	Spin Rate (rev/sec)
FLAT STEP BEARINGS					
DB-5	DRC171	R_c 39	Molykote	--	42
DB-9	"	"	Thin Foscoat	17.2	41
DB-16	"	"	Heavy Foscoat	17.2[illegible]	45
DB-17	"	"	" "	17.2[illegible]	50
DB-19	"	"	Thin Foscoat +Molycoat	17.22	38
DB-10	"	"	Heavy Foscoat + Molykote	17.19	52
DB-11	"	"	"	17.19	47
SPHERICAL PIVOT BEARINGS					
DB-21	DRC173	R_c 48	Molykote	17.19	35
DB-20	"	R_c 50	"	17.19	34
DB-13	"	R_c 55	"	17.23	31
BALL BEARINGS					
DB-22	Nice #715	--	--	17.58	122
DB-23	"	--	--	17.6[illegible]	[illegible]
DB-24	DRC389	MBI Steel R_c 59		17.52	28
DB-25	"	HSS Steel R_c 66		17.58	31